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Epitaxial relationships of clinopyroxene-hosted magnetite determined using electron backscatter diffraction (EBSD) technique

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ABSTRACT

Crystallographic relationships between exsolved phases and their hosts are typically characterized using transmission electron microscopy (TEM) or single crystal X-ray diffraction (XRD). In this investigation, electron backscatter diffraction (EBSD) was used to determine the epitaxial relationships of exsolved laths of magnetite in clinopyroxenes from three sampling sites in the Cretaceous Messum Complex of Namibia. Two orientations of magnetite inclusions are found with their long axes subparallel to [100] and [001] of the host clinopyroxene. Inclusions subparallel to $[100]_c$ have $[\bar{1}10]_m$ // $[010]_c$, $(\bar{1}\bar{1}1)_m$ // $(\bar{1}01)_c$, and $[112]_m$ // $[101]_c$. Inclusions subparallel to $[001]_c$ have $[\bar{1}10]_m$ // $[010]_c$, $(111)_m$ // $(100)_c$, and $[\bar{1}\bar{1}2]_m$ // $[001]_c$. The EBSD-derived orientation relationships agree well with previous TEM and XRD studies on similar materials.

The crystallographic relationships obtained with EBSD are used in conjunction with optimal phase boundary theory to determine the exsolution temperature of the magnetite inclusions, which is of importance to paleomagnetic studies. For one sample, this temperature (840 ± 50 °C) can be compared with that (865 ± 25 °C) derived from a more widely used cation exchange geothermometer. Thus it appears clear that exsolution occurred well above the Curie temperature of pure magnetite (580 °C).